Predicting mechanical restraint using machine learning

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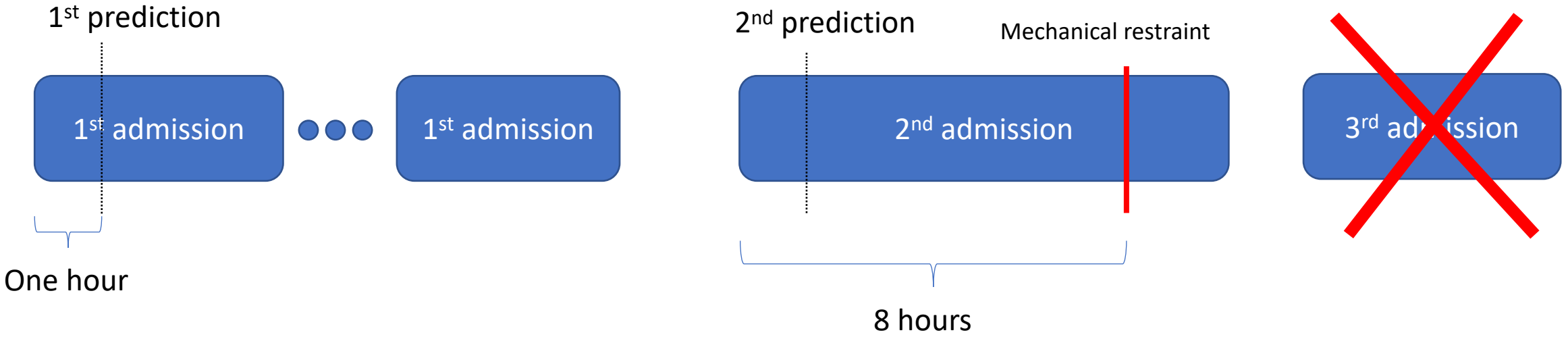
Mechanical Restraint - Background

- Physical restraint of psychiatric inpatients using leather belts/straps
- Used to prevent imminent violence from patients
- Worldwide inpatient prevalence 1-20%
- Associated with many adverse effects - both psychological and physical trauma
- Some risk factors have been identified – male, schizophrenia, involuntary admission
- Paucity of studies trying to predict mechanical restraint episodes
- Identification of at-risk patients would enable launching interventions to reduce risk

Predicting Mechanical Restraint – Aim & Design

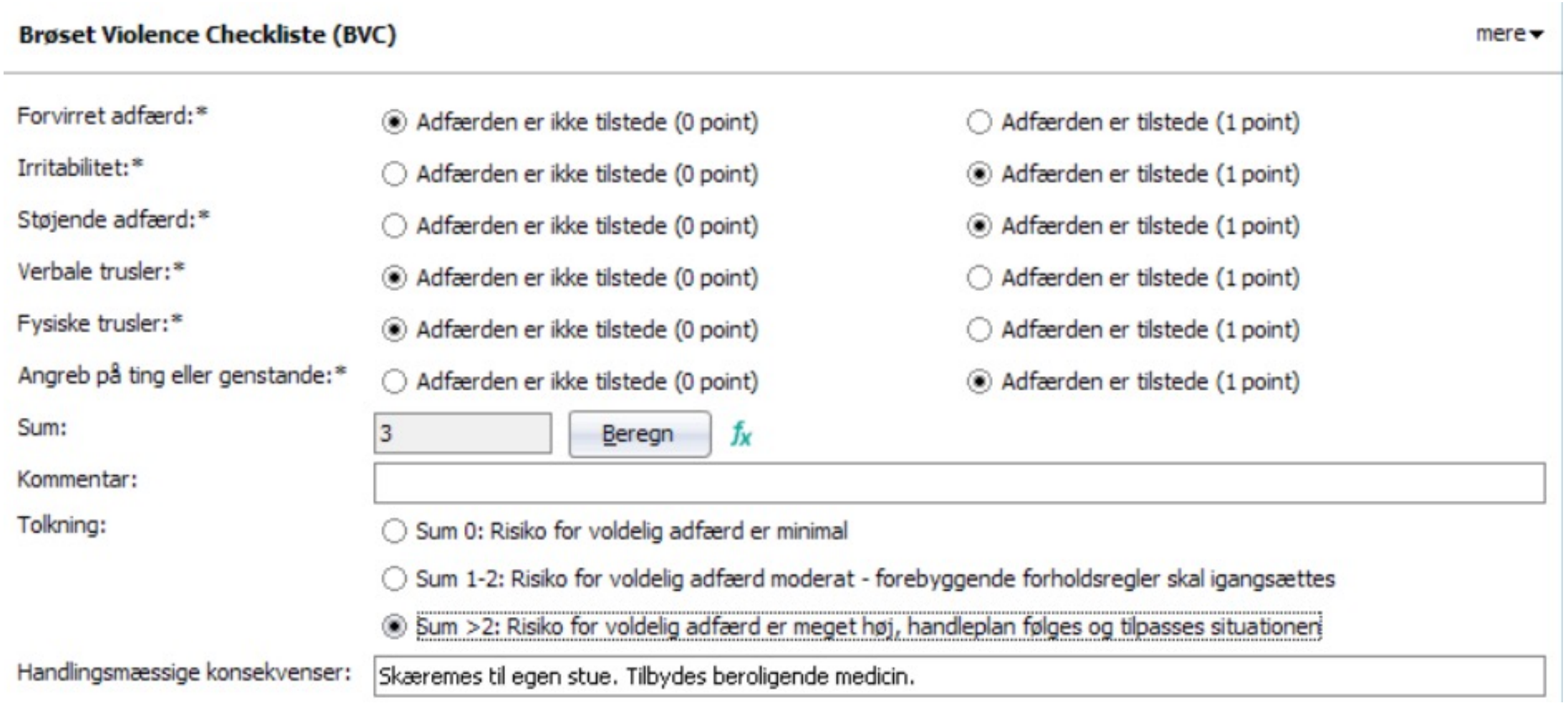
- Aim: Develop a model that predict mechanical restraint during admission
  - Based on data available up to the first hour of admission
  - Prediction should be valid for the first three days of the admission
  - Only first mechanical restraint episode
- Study design



Setting & data

- Setting - Central Denmark Region
  - 1.3 million inhabitants
  - 7 psychiatric hospitals (run by one administrative unit)
  - Total psychiatric bed capacity was 455
- Data
  - Electronic health record implemented in Central Denmark Region (MidtEPJ)
    - Information from the psychiatric hospitals spanning 4 years (2012-2015)
    - A total 56.000 patients
    - Administrative data
    - Clinical notes
  - The Danish Psychiatric Central Research Register
  - The Register of Coercive Measures in Psychiatric Treatment

Materials – Clinical notes in MidtEPJ



Brøset Violence Checkliste (BVC) mere

Forvirret adfærd:*	◉ Adfærden er ikke tilstede (0 point)	○ Adfærden er tilstede (1 point)
Irritabilitet:*	○ Adfærden er ikke tilstede (0 point)	◉ Adfærden er tilstede (1 point)
Støjende adfærd:*	○ Adfærden er ikke tilstede (0 point)	◉ Adfærden er tilstede (1 point)
Verbale trusler:*	◉ Adfærden er ikke tilstede (0 point)	○ Adfærden er tilstede (1 point)
Fysiske trusler:*	◉ Adfærden er ikke tilstede (0 point)	○ Adfærden er tilstede (1 point)
Angreb på ting eller genstande:*	○ Adfærden er ikke tilstede (0 point)	◉ Adfærden er tilstede (1 point)

Sum: 3 Beregn f_x

Kommentar:

Tolkning:

- ○ Sum 0: Risiko for voldelig adfærd er minimal
- ○ Sum 1-2: Risiko for voldelig adfærd moderat - forebyggende forholdsregler skal igangsættes
- ◉ Sum >2: Risiko for voldelig adfærd er meget høj, handleplan følges og tilpasses situationen

Handlingsmæssige konsekvenser: Skæremes til egen stue. Tilbydes beroligende medicin.

Materials – Clinical notes in MidtEPJ

Aktuelt psykisk mere

Patienten er meget trist, græder det meste af dagen over "ting som egentlige er ligegyldige". Har mange selvbebrejdelser - både over for familien men også over hændelser der ligger mange år tilbage og som patienten ikke har tænkt over i lang tid…

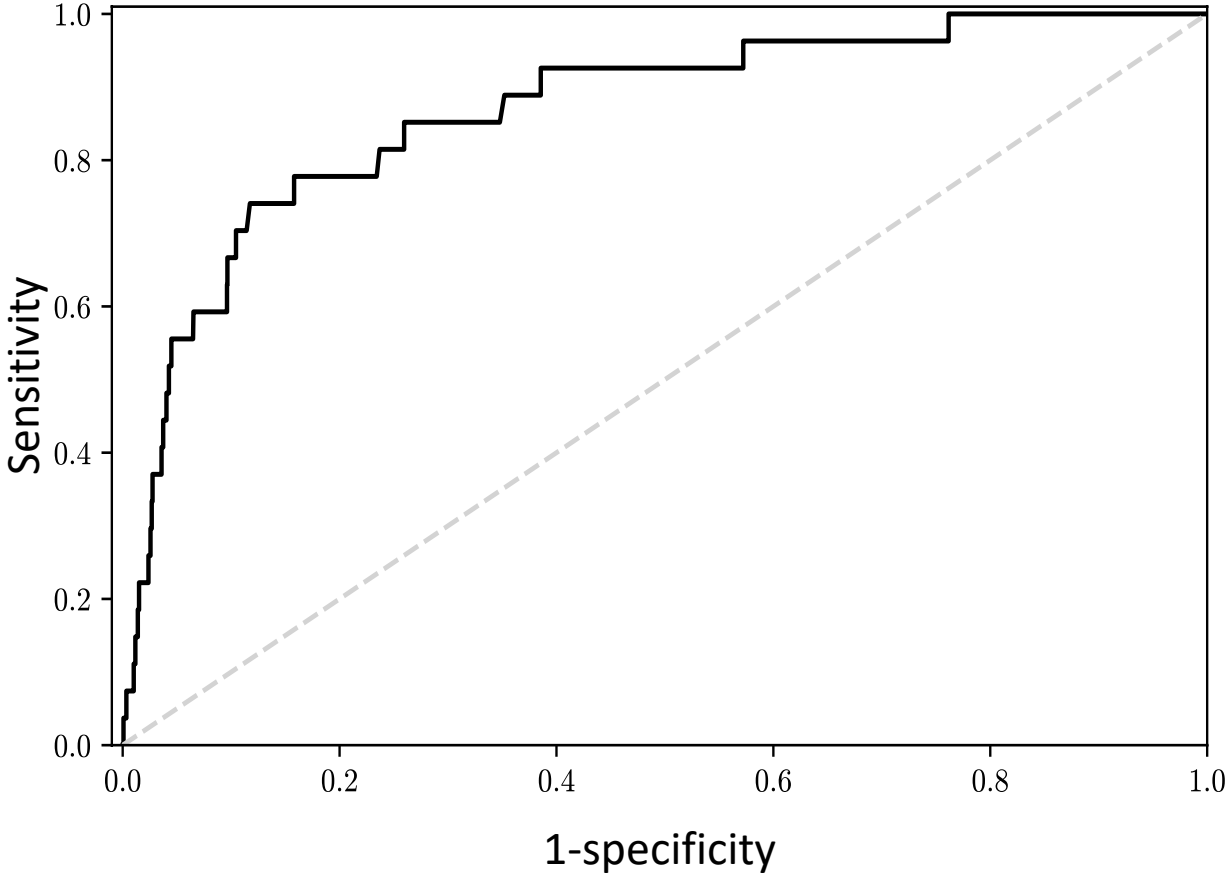
Predicting Mechanical Restraint - Method

- Method
  - Split sample (70% training dataset and 30% test dataset)
  - Model development
    - 8 features from structured data (sex, diagnoses, age, BVC ect.)
    - 78 features from unstructured data (clinical notes in natural language)
      - Selected specific themes
      - Notes with the same theme were concatenated
      - Text pre-processing
      - Vector space model
      - Singular value decomposition
    - Lasso regression (least absolute shrinkage and selection operator)
    - Random forest
    - Support vector machine
    - Stepwise forward logistic regression
    - Neural network

Predicting Mechanical Restraint – Results

- Results
  - A total of 5,050 patients were included with a total of 8,869 admissions
  - 100 admissions where the patient was restraint
  - The random forest was validated in the test set
  - At 94% specificity the sensitivity was 56% and the PPV was 8.1%
  - A total of 45 features were used by the random forest
  - Of the 10 most important features 8 were derived from clinical notes in natural language

Area under curve = 0.87 (95% CI: 0.79-0.93)



Predicting Mechanical Restraint – Results

Data Source	Terms (Freely translated from Danish)	Label
Register (type of admission)	N/A	N/A
MidtEPJ (BVC score)	N/A	N/A
MidtEPJ (Subjective Mental State)	Department, paper, somatic, red, admission	Somatic comorbidity
MidtEPJ (Subjective Mental State)	I, I, ask, we, say	Sparse/non-coherent verbal response
MidtEPJ (Subjective Mental State)	Answer, question, describe, asked, answered	Non-informative verbal response

Conclusion

- Compared to other risk scores used in psychiatry:
  - Based on accuracy (AUC) our model is clinically useful
  - No time spent scoring patients